STATE OF IOWA

1932

# Courses of Study for High Schools

# BIOLOGY

Issued by the Department of Public Instruction

AGNES SAMUELSON, *Superintendent*



Published by
THE STATE OF IOWA
Des Moines

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# FOREWORD

This course of study is one of a series of curriculum publications to be presented the high schools of the state from time to time by the Department of Public Instruction. It has been prepared by a subject committee of the Iowa High School Course of Study Commission working under the immediate direction of an Executive Committee. If it is of concrete guidance to the teachers of the state in improving the outcomes of instruction, the major objective of all who have contributed to its construction will have been realized.

From the start the need of preparing working materials based upon cardinal objectives and adaptable to classroom situations was emphasized. The use of the course of study in the development of proper pupil attitudes, ideals, habits, and skills was the criterion for selecting and evaluating subject matter material. At the same time it was important to consider the relation of the single course of study unit to the variety of textbooks used in the high schools of the state. The problem before the committees was that of preparing suitable courses of study representing the best in educational theory, practice, and research, and organized in such a way as to guide the teachers in using the textbook to greater advantage in reaching specified outcomes of instruction.

The selection of texts in this state is a function of the local school boards. The Department of Public Instruction and the committees do not recommend any particular text as essential to the working success of this course of study. The titles listed on the following pages are not to be interpreted as having official endorsement as against other and newer publications of value. They were found upon investigation to be in most common use in the high schools of the state at the time the units were being prepared; a follow-up survey might show changes.

Although many valuable studies have been made in the effort to determine what to teach and how to teach it, and to discover how children learn, these problems have not been solved with finality. For that reason and because no fixed curriculum can be responsive to changing needs, this course of study is to be considered as a report of progress. Its revision in accordance with the enriched content and improved procedures constantly being developed is a continuous program of the Department of Public Instruction. Your appraisal and evaluation of the material as the result of your experience with it are sincerely requested.

# ACKNOWLEDGMENTS

The Department of Public Instruction takes this opportunity of thanking the many college specialists, school administrators, and classroom teachers who have helped with this program. Without the active coöperation of the educational forces of the state it could not have even been attempted. It has had the coöperation both in general and specific ways. The support given by the Iowa State Teachers Association and the High School Principals' Section has enabled the Executive Committee to meet and also to hold meetings with the Commission as a whole and with the chairman of subject committees.

Special acknowledgment is given the Executive Committee for its significant leadership in organizing the program and to Dr. T. J. Kirby for his valuable services in directing its development. Sincere gratitude is also expressed to the various committees for their faithful and skillful work in completing the subject matter reports assigned them and to Dr. C. L. Robbins for his careful and painstaking work in editing the manuscripts. The state is deeply indebted to the High School Course of Study Commission for its expert and gratuitous service in this enterprise. Credit is due the publishers for making their materials accessible to the committees and to all who served in advisory or appraisal capacities. Many of their names may not have been reported to us, but we acknowledge our appreciation to every one who has shown an interest in this significant program.

In the following committee list, the positions held by members are given as of the school year 1928-1929.

## IOWA HIGH SCHOOL COURSE OF STUDY COMMISSION

### Executive Committee

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H. M. Gage, President, Coe College, Cedar Rapids
M. S. Hallman, Principal, Washington Senior High School, Cedar Rapids
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F. H. Chandler*, Superintendent, Public Schools, Sheldon

### SCIENCE

Lillian Hethershaw, Instructor in Science and Education, Drake University, Des Moines, Chairman

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* Superintendent Chandler was appointed in 1929 to fill the vacancy created by the resignation of Superintendent Menefee.

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Mrs. Gladys Bailey, High School, Muscatine
Chas. Carter, Professor of Biology, Parsons College, Fairfield
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Wm. B. Zuker, Head of Department of Chemistry, University of Dubuque, Dubuque

Agnes Samuelson
Superintendent of Public Instruction

# GENERAL INTRODUCTION

At the first general meeting of the various subject committees a suggestive pattern for the courses of study, embodying the fundamental needs for teaching, was projected. Four crucial factors that should be emphasized in any course of study to make it an instrument that would cause teachers to consult it for guidance in the performance of their daily work were set forth as follows: objective, teacher procedures, pupil activities, and evidences of mastery.

**Objectives**—The meaning of objectives as here used is those concepts which are set up for pupils to achieve. As used in current practice, there is a hierarchy of objectives as shown by the fact that we have objectives of general education, objectives for various units of our educational system such as those proposed by the Committee on Cardinal Principles, objectives for subjects, objectives for a unit of instruction, and objectives for a single lesson. In each level of this hierarchy of objectives a constant element is expressed or implied in the form of knowledge, a habit, an attitude, or a skill which the pupils are expected to acquire.

In the entire field of secondary education no greater problem confronts us than that of determining what these fundamental achievements are to be. What shall be the source of those objectives, is a problem of too great proportions for discussion here,-but it is a problem that each committee must face in the construction of a course of study. A varying consideration of objectives by the various committees is evident in the courses of study they have prepared. The value of the courses varies in terms of the objectives that have been set up, according to the value of the objective in social life, according to the type of mental techniques which they stimulate and exercise, and according to the objectivity of their statement.

**Pupil Activities**—In our educational science we are attaching increasing significance to self-activity on the part of the learner. Recognition is made of the fundamental principal that only through their own activity pupils learn and that the teacher's rôle is to stimulate and direct this activity. No more important problem faces the curriculum-maker than that of discovering those fundamental activities by which pupils learn. In a well-organized course of study, that series of activities, in doing which pupils will attain the objectives set up, must be provided. These activities must not be chosen in a random fashion, but care must be taken that appropriate activities for the attainment of each objectives are provided.

**Teacher Procedures**—With the objectives determined and the activities by which pupils learn agreed upon, the function of the teacher in the pupil's learning process must be considered. In a course of study there should appear those teacher procedures of known value which make learning desirable, economical, and permanent. Here our educational science has much to offer. Where research has demonstrated with a high degree of certitude that a given technique is more effective in the learning process than others, this technique should be included in a course of study. Common teaching errors with sug-

gested procedures to replace them may be included. Pupil difficulties which have been discovered through research should be mentioned and methods of proven value for meeting these difficulties should be included. Suggested ways of utilizing pupils' experiences should be made. And as important as any other feature is the problem of motivating learning. Whatever our educational research has revealed that stimulates the desires of pupils to learn should be made available in a course of study. Valuable types of testing should be incorporated as well as effective type assignment. The significance of verbal illustrations as evidence of comprehending the principle at issue should be featured as a procedure. Where there is a controlling procedure of recognized value such as is recognized in general science—bringing the pupil into direct contact with the phenomena studied—forceful effort for the operation of this procedure should be made.

**Evidences of Mastery**—What are to be the evidences of mastery of the objectives set up? There are all degrees of mastery from the memoriter repetition of meaningless terms up to a rationalized comprehension that shows grasp of both the controlling principles involved and the basic facts necessary to a clear presentation of the principles. These evidences of mastery may be in the form of dates *to be known,* formulae *to be able to use,* types of problems *to be able to solve,* quality of composition *to produce,* organization of materials *to be made,* floor talks *to be able to give,* papers *to be able to write.*

In no part of educational procedure is there need for more effort than in a clear determination of those evidences, by which a well-informed teaching staff can determine whether a pupil has a mastery of the fundamental objectives that comprise a given course. As we clarify our judgments as to what comprises the essential knowledge, habits, attitudes, and modes of thinking involved in a certain course, we can set forth with more confidence the evidences of mastery. Teachers are asking for the evidences of mastery that are expected of pupils, and courses of study should reveal them.

While these four elements constitute the basic pattern, the principle of continuity from objective to pupil activity, to teacher procedure, to evidence of mastery was stressed. The maker of a course of study must bear in mind that what is needed is an objective having accepted value; a pupil activity, in performing which, pupils gain a comprehension of the objective that is now being considered; that a teacher procedure is needed which evidence has shown is best adapted to stimulating pupils to acquire this objective for which they are striving; and that evidences of mastery must be incorporated into the course by which to test the degree of comprehension of the objective now being considered.

The courses of study vary in the degree to which these four fundamental features have been objectified and in the degree to which the principle of continuity from objective to evidence of mastery has been cared for. On the whole they will provide effective guides which teachers will use.

Realizing that these courses of study were prepared by school men and women doing full time work in their respective positions, one fully appreciates the professional zeal with which they worked and the splendid contribution to high school education which they made.

THOMAS J. KIRBY,
Chairman of the Executive Committee

# COURSE OF STUDY IN BIOLOGY

## INTRODUCTION

Biology is rapidly becoming a standard course in the high school program of studies. The committee in preparing a course of study for this subject has studied the research, textbooks, and opinions of experts to find what concepts pupils should acquire from a study of high school biology, what procedures teachers should use in aiding them to learn these, what the pupils must do in order to learn and what evidences pupils should display to show they have a mastery of biology. From this study the committee presents the following suggestive outline to guide in the teaching of the units that follow.

. The objectives from the standpoint of pupils are:

1. To acquire some appreciation of the values of science and of the self-sacrificing efforts of the great scientists

2. To acquire a knowledge of the scientific method of thinking which teaches the pupil to observe, to compare, to experiment, and to draw intelligent conclusions from the data obtained

3. To gain a knowledge of biological laws and principles, to acquire habits in healthful living, and appreciation of the principles operating in the production of better plants and animals to serve man's needs

4. To acquire a few biological principles so effectively that pupils will comprehend the principles and be able to apply them to every-day life

5. To gain a knowledge of the marvelous adjustment of the organism to its environment and of the environment to the organism

Procedures which are known to stimulate and guide pupils in acquiring the objectives of biology should be practiced by the teacher of biology. Some of these are:

1. He should keep constantly in mind the fact that biology teaching should give the pupil the habit of scientific thinking as well as give him a knowledge of biological subject matter. It should also be a means of making pupils realize that all problems to be solved efficiently must be solved by this method—by reasoning to correct conclusion on the basis of observed facts. In addition wise teaching of biology should instill ideals of the values of this type of an attack upon all problems to be solved

2. The course of study contains a relatively small number of units so that the teacher may spend more time upon the biological principles and their application specifically involved. The teacher may adjust his procedure to the various problems of the unit and hold each pupil to a high degree of mastery of these problems before he goes on to the next. He should see that pupils have a constant sense of mastery that begets confidence

3. It is hoped that every teacher will bring to the class many concrete situations illustrating the principles studied so that pupils will have many opportunities to apply them; otherwise the principles become something acquired in school for school use only and do not carry over to life situations. In other words, every biological principle studied should be applied in every situation in his environment in which it is operative

4. Research has shown for the secondary school level, that great reliance can be placed in the teacher demonstration method. Every high school biology teacher should acquaint himself with this research and make use of much teacher demonstration. The use of teacher demonstration does not mean that pupils are not to do individual investigation and experimentation in the class work, but it does insure a focalization of the class on the problems at hand and allows the teacher to guide the thinking of the group

5. The self-activity of the learner is provided for through the suggestions offered in connection with each unit of work. These suggestions are to be utilized through assignments, thus assuring the weaning of pupils from teacher dependence

6. The teacher should have plenty live plant and animal life in the biology room for observation, better to have the laboratory smell of white mice than formaldhyde. The teacher should make an inventory of her course of study and text early in the school year to see what live materials can be collected by pupils for use in class work later in the year. The following are suggestions:

a. Make excursion to a pond for collecting native water plants, insect larva, tadpoles, fish, and snails for use in stocking an aquarium

b. Make excursion to collect land snails, turtle, garter snake, toad, and frog for stocking terrarium

c. Make excursion to collect or have various groups collect cocoons and chrysalis

d. Collect as many insect forms as possible to keep in laboratory

e. Collect fungus growths on red cedar, smut on corn, and various toadstools, box and label

f. Collect leaves of apple and hawthorn that show rust and leaves of lilac that show mildew, box and label these

g. Collect various fruits to show seed dispersal, box and label these

h. Collect various leaves of trees. Press and box these

i. Fill a pail with soil to which a great deal of humus has been added, then collect earthworms and place in the soil. These can be used for study and for food of the various animals in the laboratory

j. Slip plants and later pot them for class use

7. Plan some scheme whereby pupils will be organized into groups to be responsible for providing a bulletin board appropriate to each unit, for filing bulletin board materials, for bringing in current literature that relates to unit being studied, and for caring for the laboratory equipment, etc.

8. Look over carefully the pupil activities suggested in each unit. The use of these will suggest teacher procedures for creating active attitude on part of pupil and caring for individual differences

9. Devise tests over units using the evidences of mastery list of each unit as a guide for selecting items that should be covered in the test. When tests are used at the end of each unit, allow some time for the review of principles and facts that have not been mastered by the pupils. Plan to make the first teaching of such a high standard that little time will need to be spent on reteaching

Pupil activities should be planned and guided toward effective accomplishment. It is the hope of the committee that the suggested pupil activities in each unit will provide activities by which pupils will learn by doing, furnish material to aid teacher in taking care of individual differences in the class, provide a means of creating an active attitude on the part of the pupils, and wean the pupil from teacher dependence

These suggested activities are intended to encourage pupils to

1. Observe the phenomena of his every-day surroundings
2. Read widely on topics that relate to units being studied
3. Tabulate data in connection with individual or group work
4. Prepare and give to class reports of high standard
5. Outline and carry on individual and group projects in connection with the unit
6. Summarize the work of units
7. Seek illustrations of biological principles and report to class
8. Recognize in their native habitat, plants and animals by their calls and their activities

The evidences of mastery in each unit are designed to:

1. Give teachers a basis by which they may estimate the degree of acquisition made by the pupil
2. Give teachers a basis upon which to build pre-tests, instructional tests, and final tests over each unit

Evidences of mastery on the part of the pupil are:

1. Collecting his own facts, making his own hypothesis, verifying or disproving by experiment, reasoning to final judgment, and evaluating critically his final conclusions
2. Applying biological principles studied to the common life situations about him
3. Proposing significant questions and problems on which he desires information

A final evidence of mastery will be proficiency of pupils in handling a problem. The following procedure is suggested:

Near the end of the school year individual pupils or small groups of pupils should be assigned a problem that will require making use of the scientific method of attack which the teacher has been striving to have pupils acquire. The proficiency with which pupils handle this problem should be one of the bases for judging how well the pupil has mastered one major outcome of studying biology, that of attacking and solving a problem

*Suggested Problems for Pupils*

Surveying trees in the park or on the school grounds

Collecting eggs of frogs and salamanders and finding out the stages in their development

Keeping a bird census during spring

Finding out if a bog terrarium can be maintained in the laboratory

Finding out if potatoes and tomatoes can be grafted

Finding out if showy fish can be reared and cared for in the laboratory

Testing out some of the common accepted beliefs such as: the relation of weather to the moon, equinoctial storms, the relation of plant growth to the phases of the moon

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## I. WHAT BIOLOGY IS

A. The meaning of biology

B. The similarities and differences of living and non-living things

C. The changes going on in living and non-living things

D. The processes carried on by living things

E. The unit of structure of living things

### Unit Objective

To acquire a general view of the meaning of biology, and the methods used in its study

### Specific Objectives

1. To recall and use previously acquired biological knowledge

2. To acquire a definition of biology from present knowledge

3. To understand how sciences are studied

4. To realize how biology is related to other sciences

5. To acquire and understand scientific terms as an aid to reading intelligently the biology of the press

6. To realize that many professions such as medicine and dentistry are but practical applications of the science of biology

### Teacher Procedures

1. The subject matter set forth in these units is concrete and should furnish opportunity to use the scientific method of thinking. Teachers of biology should direct pupils toward the problem-solving attitude of mind throughout the course, playing an active part in guarding against errors in pupils' thinking, giving ideals of accuracy of observation and recording, giving drill in evaluating data, withholding judgment until all possible data are collected and evaluated, and giving drills in reasoning to conclusions on the basis of the observed facts

2. The unit might be started by asking the pupils questions about plants and animals. This procedure will help the teacher to discover the pupils' biological knowledge

3. Have pupils formulate definitions of what they understand by the study of biology, keeping in mind that the final definition will be again discussed at the completion of the course

4. To illustrate what is meant by the problem-solving attitude of mind, have pupils read some such material as the work done by Louis Pasteur in finding out what caused the silk worms of Southern France to die in large numbers, or how causes of yellow

| Pupil Activities | Evidences of Mastery |
|---|---|
| Pupils will | |
| 1. Make insect cages for keeping a few live insects in the laboratory | 1. To know biology deals with living things |
| 2. Collect insects such as crickets, locusts, beetles, and find out about their food habits and keep them in the laboratory for observation. Keep records of behavior of these insects | 2. To know biology includes many special branches of science |
| 3. Collect pond life and start to stock a fresh water aquarium | 3. To know that the knowledge of biology is used to protect useful plants, to give pleasure, to use leisure time, to cure sickness, to prevent sickness, to improve useful plants and animals, to protect and increase useful plants and animals, to lengthen the span of life, and help us understand ourselves |
| 4. List examples of practical use made of the knowledge of biology. Have a committee prepare a composite list of these examples and report to the class. Have the report organized in some form giving rank to the various uses | 4. To know the differences in organic and inorganic matter |
| 5. List ways in which biology has been of value to man | |
| 6. Tabulate ways in which plants and animals resemble each other and how they differ from all inorganic things | 5. To know that living things (plants and animals) grow, reproduce, usually move, obtain food, excrete wastes, assimilate food and die |
| 7. List all articles in classroom under two headings, organic and inorganic, and be able to defend why you placed them in the column you did | 6. To know that both organic and inorganic things undergo changes |
| 8. List ten physical and ten chemical changes and tell why they classified them as such | 7. To know that all changes can be classified as physical or chemical, and to know the meaning of each type of change |
| 9. Find out and report the number of known elements | 8. To know what is meant by element, compound, and mixture |
| 10. Make a collection of a few elements, label, and bring them to the classroom for display | 9. To know that living things are composed chiefly of 10 to 15 elements |
| 11. List the elements found in living things | |
| 12. Make a collection of a few compounds, label, and bring to classroom for display | |

| Specific Objectives | Teacher Procedures |
|---|---|
| 7. To discover how biology teaches us to know, to enjoy, to protect, to increase, and improve useful plants and animals, and how to avoid and to destroy harmful ones | and malaria fever were discovered. Use these as class discussions formulating by steps how the work was accomplished |
| 8. To realize that life can be defined in terms of growth, irritability, reproduction, and metabolism powers that non-living things do not have | 5. Taking the word biology to mean the study of living things should raise the question as to what is living or non-living |
| 9. To gain a knowledge of processes carried on by living things that are not carried on in non-living things | 6. Before texts or references are used encourage pupils to analyze their concepts of living things by listing characteristics of both living and non-living things |
| 10. To distinguish between organic and inorganic materials | 7. From general information and from references read, have class discussion on the life processes carried on by plants and animals that are not carried on by inorganic things. Make class summary of all information, evaluate and put into final form differences between organic and inorganic materials |
| 11. To realize that living and non-living things change | 8. Make a brief study of needs of plants and animals and make comparisons. Have plenty of living specimens of plants and animals in laboratory for observation |
| 12. To gain a knowledge of the types of changes living and non-living things undergo and to know that these changes are sources of energy | 9. Take up changes that are constantly taking place in organic and inorganic materials. In so far as possible have pupils set up their own problems. This can be done by careful questioning on the part of the teacher. Have teacher or pupil demonstrations to show both physical and chemical changes and be sure that as many practical applications of these changes are made as possible |
| 13. To acquaint pupils with the changes which living and non-living things undergo and to know they are directly concerned in vital processes | 10. In order to understand chemical changes pupils should have clearly in mind what is meant by elements, compounds, and mixtures. Have pupils report on number of elements known to science and list the most common ones found in organic material. This should bring out the fact that in our food stuffs three elements (carbon, hydrogen, and oxygen) are common to all |
| 14. To understand what is meant by elements, compounds, and mixtures | |

### Pupil Activities

13. Make a Hall of Fame of biologists who worked on cells

14. Try to make a good model of a resting cell from plasticine or clay to be left in the laboratory for future reference

15. Report on history and use of the microscope and its effect on the advancement of biology

16. Bring into the laboratory all plants and animals that can be cared for and studied

17. Summarize the main points of the unit

### Evidences of Mastery

10. To know that these 10 to 15 elements are enough to compose a wide variety of compounds
11. To know that organic matter is complex and can neither be created nor destroyed
12. To know that fats, proteins, and carbohydrates contain three common elements, carbon, hydrogen, and oxygen

13. To know that all living things have certain life processes in common

14. To know that these processes are sensation, motion, respiration, food getting, reproduction, nutrition, and excretion

15. To know that all food comes originally from green plants

16. To know a cell is a unit of structure and function of all living things

17. To know that protoplasm is a substance that is peculiar to all living things

18. To know the cell embraces all the heredity qualities of the organism within its nucleus

19. To know that plants and animals may consist of single cells and that they always start with a single cell

| Specific Objectives | Teacher Procedures |
|---|---|
| 15. To realize that all living things have certain processes in common | 11. To understand living plants and animals, pupils should know not only something of the elements that make them up and the changes that they undergo, but they need to know something of their life functions and needs. These needs should be discussed briefly in this unit, but will be taken up later. (Nutrition, excretion, reproduction, respiration, food-getting) |
| 16. To discover that all life depends on food which comes from green plants | 12. After life functions and composition of living things have been taken up, bring out by class discussion that if life is to continue, there must be somewhere in nature where food is manufactured (the green plant) |
| 17. To know that the cell is a unit of life | |
| 18. To realize that protoplasm is the living stuff and that the functions of a cell are the results of its protoplasm | 13. To study the unit of structure of living things does not necessarily require microscopes. One microscope with demonstration ocular might be useful but still better is a projection lantern. Roots of wandering Jew grown in water and observed in water show cells that can be seen with unaided eye. Onion skin stained with iodine will show cells by using a hand lens. Make careful enlarged drawings to show parts of the cell. Pupils should read various references on the cell, its contents and characteristics; and should know that the problem of heredity taken up later in the course involves an understanding of cells |
| 19. To discover that all cells produce new cells by division | |
| | 14. Summarize the work of the unit by working out an outline as a class problem. This should be an individual problem after the first unit |
| | 15. Test pupils' knowledge of principles covered by means of some type of objective test |
| | 16. Have pupils write a short paper on "Basic Differences between Living and Non-living Things" using class notes and observations as a basis |

**References**

1. Clements, F. E., *Living Things, Chapters* 1-5, Iroquois Publishing Co.

2. Gruenberg, B. C., *Biology and Human Life,* Chapters 1-2, Ginn

3. Locy, W. A., *Biology and Its Makers,* Henry Holt

4. Moon, T. J., *Biology for Beginners,* Chapters 1-5, Henry Holt

5. Smallwood, W. M., Reveley, I. L., and Bailey, G. A., *New General Biology,* Chapters 1-5, Allyn and Bacon

6. "Starting and Maintaining a Balanced Fresh-water Aquarium," *Turtox Service Leaflet No. 5,* General Biological Supply House, Chicago, Illinois

7. Wheat, V. M., and Fitzpatrick, J. B., *Advanced Biology,* Chapters 2-6, American Book Co.

## 11. THE LIVING GREEN PLANT

### Unit Objective

To show that life is dependent on food, and all food comes originally from green plants

### Specific Objectives

1. To realize that all food comes directly or indirectly from green plants

2. To know the parts of a typical green plant and the function of these parts

3. To know how tne various parts of the green plant carry on their work

4. To gain a knowledge of how the life functions of plants and animals are similar and how different

5. To discover the chief functions of a leaf

6. To discover how green plants manufacture food

7. To know in general the structure of leaves

8. To discover how leaves protect themselves from loss of moisture

9. To know the uses of plant leaves to man

### Teacher Procedures

1. Review briefly the processes carried on by living things. Show that food is required to carry on these processes and that if life is to continue there must be some place where food is manufactured. (Green plant)

2. Use any common plant on hand, such as geranium and give gross presentation of a plant as a working unit, having a purpose in life

3. Take up briefly the parts of a green plant, roots, stem, leaves, and flowers. Study briefly the various forms of each and their chief functions

4. Compare life functions of plants and animals

5. After the plant as a whole is studied, each of the parts, leaf, root, stem, and flower should be carefully studied to show how they are adapted for their work and the various functions performed by the parts

6. Suggestions for leaf study: Such topics as general structure, arrangement to secure light, types of leaves, why some leaves fall in autumn, and adaptations, should be taken up before the functions of leaves are studied. Use epidermis of Wandering Jew or other leaf to show structure of the upper and lower covering of leaf. Use charts and projection apparatus wherever they are available.
Take up briefly the variation in epidermis of plants
Show how each tissue is adapted for its work

### Pupil Activities

Pupils will

1. Make a list of plants used for food. If possible look up the amounts of each produced a year and make a graph to show this information

2. Select twenty or more definite statements from a botany or biology book about the use of plants to man and make up a set of true-false questions

3. Collect leaves to show their various forms, press, mount and file them in the biology laboratory for future classes

4. Bring in all the forms of modified leaves possible such as tendrils, thorns, and traps. Mount them and leave them for exhibit

5. Measure several large leaves as rhubarb, burdock, and plantain and calculate the surface exposed

6. List the tissues seen in cross section of a leaf, then in column two give a statement about the structure of the tissue and in column three give functions of the parts

7. Observe various leaves and report on their change of position with the sun

8. Bring into the laboratory a collection of leaves used for food

9. Find out how plants can self bleach

10. List plants they know that are not green and cannot make their own food

11. Find out from references any plants that can be reproduced by their leaves

### Evidences of Mastery

1. To know in what way green plants are useful to man

2. To know the parts of a higher plant, roots, stems, leaves, and flowers, and know the functions of each part

3. To know the differences in annuals, biennials, and perennials

4. To know that green plants differ from animals in the fact that they are (1) not conscious (2) they are unable to move about (2) they make their own food

5. To know the gross structure of a leaf

6. To recognize different types of leaves and have some knowledge of the various leaf positions

7. To use such terms as petiole, blade, venation, pinnately compound, palmately compound, and margin correctly in describing leaves

8. To know why leaves fall in the autumn from broad-leafed trees in this climate

9. To know the use of the tissues of a leaf—epidermis, palisade layer, spongy tissue, veins, stomata, and cuticle

10. To have a good working knowledge of photosynthesis, and the conditions necessary for photosynethesis

| Specific Objectives | Teacher Procedures |
|---|---|
| 10. To gain a knowledge of the gross structure of a root | 7. Take up the life processes carried on by the leaf of green plants: (1) photosynthesis, (2) digestion, (3) excretion, (4) respiration, (5) assimilation, and (6) circulation. Transpiration though not a life process is made necessary by these processes. Use any biology manual for teacher demonstrations or pupil demonstration on these processes |
| 11. To realize use of root to plant | |
| 12. To know how roots are classified as to duration | 8. Economic uses of leaves may be studied |
| 13. To understand the response of roots to water and gravity | 9. After the study of leaves take up the root. Show that the success in food manufacturing in leaves depends upon the roots. Suggestions for root study: Use carrot for the study of the tissues of root. Wandering Jew grown in water may be used to show the root cap. Radish seeds planted on moist blotting paper for 48 hours will show root hairs Take up uses of roots to plants and man. Classification of roots as to duration. Demonstrate region through which liquids rise and the response of roots to moisture Economic use of roots |
| 14. To know the use of plant stems | |
| 15. To discover how monocot and dicot stems differ in structure | 10. Suggestions for stem study: Use twigs of such plants as Shagbark hickory or horse chestnut to study external structure of stems. An old tree stump may serve to study an older stem of a dicot. Use cornstalk for a monocot stem. Summarize the differences in monocot and dicot stems and the use of all stems. Lantern slides and charts will help to clear this up Study the various forms of stems as well as their economic use |
| 16. To understand the cause of annular rings in woody perennial stems | |
| 17. To understand the parts of a flower | 11. Flower study: Use any simple flower in season to study structure. Study from observation or references the types of pollination, and the various adaptations for pollination. The difference between pollination and fertilization should be carefully studied. A brief discussion of which kind of pol- |
| 18. To acquire knowledge of the essential organs of a flower | |
| 19. To understand how seed is produced | |
| 20. To understand how pollen is transferred | |
| 21. To understand tne distinction between fertilization and pollination | |
| 22. To acquire knowledge of the agencies that aid in pollination | |

| Pupil Activities | Evidences of Mastery |
|---|---|
| 12. Bring in as many forms of roots as possible. (Fibrous, tap, aerial, fascicled and adventitious) Wash them and make a record by notes, drawings or photographs | 11. To be able to compare photosynthesis and respiration |
| 13. List roots used for food being careful not to include stems | Suggestion: |
| 14. List ways in which roots and stems differ | |
| 15. Make a collection of specialized stems as bulbs, underground stems, tubers, and corms | |
| 16. List all the ways stems are used in propagation of plants | |
| 17. Look up and report on the use and manufacture of rayon silk | |
| 18. Look up and report on the fig industry | |
| 19. Report on the work of Luther Burbank | 12. To know some of the economic uses of leaves |
| 20. Look up and report on interesting cases of coöperation of plants and insects in pollination: (1) The Yucca and pronubu moth, (2) fig and wasp | 13. To have an understanding of the parts and functions of a root |
| 21. Make a collection of fruits to show various methods of dispersal of their seeds | 14. To have an understanding of the effect of roots upon the soil and of osmosis and capillarity |
| 22. Look up and report on seedlessness in fruits | |
| 23. Visit public or private markets and list four plants and their products | 15. To know the effect of outside stimuli upon roots (gravity, moisture, etc.) |
| 24. Plant seeds in sawdust and on blotting paper and make a series of seedlings at various stages of development | 16. To know economic uses of roots |
| 25. Compare dry and fleshy fruits as to commercial importance | 17. To understand the function and origin of stem tissues |

| Respiration | Photosynthesis |
|---|---|
| In all parts | Only in presence of chlorophyll |
| Produce $H_2O$ and $CO_2$ | Produces foodstuffs as starch, sugar, protein, etc. |
| Oxygen taken in from air | Oxygen given off |
| Energy released | Energy taken in from stem |
| Destructive process | Constructive process |

**Specific Objectives**

23. To realize upon what basis the classification of plants into families is based

24. To understand how plants that are seedless are propagated

25. To understand what is meant by seed and fruit

26. To understand the growth of plants from seed

27. To gain knowledge of the principal agencies by which dissimulation is accomplished

28. To gain knowledge of the structure of typical monocot and dicot seeds

29. To understand what foods are stored in seeds

30. To realize the value of seeds to man

lination, self or cross pollination, may be carried on. However, this subject has been too much emphasized in the past

12. Suggestions for fruit study: Distinguish between fruit and seed. Assign references and reports on "Principal Agencies for Dispersal of Seeds." Some time should be spent on the structure of various seeds, testing of foods stored in seeds and the needs of germinating seeds. Economic importance of seeds and fruits. Use any botany or biology manual for experiments on seeds for class demonstration

13. Summarize the work of green plants. The summary can be worked out as a class problem or each pupil asked to list facts learned about green plants or an outline worked out covering the work of the unit

14. Some form of an objective test given to check on the unit

15. From knowledge gained in the study of this unit write a brief but accurate paper on "Why We Eat Sunshine"

**Pupil Activities**

26. Report on Asa Gray and his work

27. List at least 100 concepts from their work on the green plant

28. Try various forms of grafting

29. Outline and summarize the work of the unit on green plants

**Evidences of Mastery**

18. To know the following about the differences in the stems of monocotyledons and dicotyledons

| | : Dicots | : Monocots |
|---|---|---|
| Cambium | : A permanent cambium | : No permanent cambium |
| Arrangement of bundles | : In a distinct ring | : Scattered throughout the stem |
| Bulk of stem | : Wood | : Pith |
| Growth | : Continuous in height and thickness | : In height only |
| Examples | : Common trees and plants | : Grasses, lilies, palms |

19. To be able to identify the following on a twig; leaf scars, bundle scars, lateral buds, terminal buds, scars made by bud scales, and lenticels

20. To know the essentials of grafting. (Cambium of stock and scion must be in close contact)

21. To recognize all parts of a complete flower (calyx, corolla, pistil, stamens)

22. To know all flowers are not complete

23. To know the meaning of diecious, monecious, staminate, and pistillate flowers

**Notes by Teacher**

### Evidences of Mastery

24. To know the accurate use of the word pollination, fertilization, fruit, and seed

25. To have an accurate knowledge of reproduction among flowering plants

26. To know the parts of a typical monocot seed, and a dicot seed

27. To have an acquaintance with the problems of germination

28. To have a knowledge of the physiological processes necessary for growth

### References

1. Beal, W. J., *Seed Dispersal,* Ginn

2. Coulter, J. M., *Plant Relation,* Appleton

3. Coulters, J. G., *Plant Life and Plant Uses,* American Book Co.

4. Literature from Wild Flower Conservation Association, Washington, D. C.

5. Toothaker, C. R., *Commercial Raw Materials,* Ginn

6. Transeau, E. N., *General Botany,* World Book Co.

7. Weaver, J. E., *Root Development of Field Crops,* McGraw Hill

## III. HOW THE SIMPLE PLANTS GROW AND MULTIPLY

### Unit Objective

To become acquainted with some of the groups of lower plant life and know something of their habits and use to man

### Specific Objectives

1. To find out on what basis plants are classified into groups

2. To gain a better knowledge of the world in which we live, by becoming acquainted with some of the lower plant forms

3. To gain a knowledge of how lower plant forms carry on their life processes of food getting, reproduction, growth, excretion, etc.

4. To gain a knowledge of the means of reproduction in lower plant forms

5. To gain knowledge of how lower plant forms without roots, stems, and leaves carry on their life processes

6. To gain a knowledge of how the lower plant forms are adjusted to their environment

### Teacher Procedure

1. Have on hand for class observation examples of some lower plant forms as bread mold, rust on apple leaves, smut on corn, pleurococcus from tree bark, lichens from bark, moss, algae from pond, mildew on lilac leaves, and ferns. Have class observe these specimens carefully and list ways they differ from seed producing plants. Show how plants, like animals, are placed into groups on the basis of structure. Then have pupils make three headings and place all the specimens under one of the three and give a reason for putting them under that number

2. Work out a simple classification together using various references

Example

Branch I. Plants having no differentiation into true stems, roots and leaves (thallophytes)

A. Splitting plants (schizophytes)

B. Chlorophyll-bearing thallophytes (algae)

C. Thallophytes without chlorophyll (fungi)

D. Compound growth of fungi and algae (lichens)

Branch II. Mosses. No vascular system (bryophytes)

Branch III. Ferns. Vascular system but no seeds (pteridophytes)

Branch IV. Seed-bearing plants (spermatophytes)

### Pupil Activities

Pupils will

1. Make a collection of lower forms of plant life. Later in the unit these can be classified into their group, labelled and put into the permanent teaching collection in the biology laboratory

2. Use Gruenberg's *Biology and Human Life* and report on the classification of the plant kingdom

3. Report on special methods and regulations in hospitals

4. Look up and report on current activities in the way of legislation regarding markets and cold storage plants

5. Make a collection of the commercial products in which microörganisms play a part (vinegar, cheese, rotting of flax, etc.)

6. Report on results of germicides as means of control for bacteria. Obtain mouth cultures from the mouth-rinsing and place in petri dish, then a similar rinsing after the use of a commercial mouth wash. Report results

7. Make a collection of algae from a pond. Place in an aquarium and try to name them

8. Make a collection of algae from tree trunks. Find out how they get their food and grow and their value

9. Report on ways bacteria may be useful

10. Report on means of natural defences against bacteria

11. Report on artificial protection against bacteria

### Evidences of Mastery

1. To know that plants and animals are classified into groups on the basis of structure

2. To know lower forms of plant life may reproduce by cell division, spores, and budding but possess no flowers and therefore no seeds

3. To know that many of the lower plant forms bear no chlorophyll and therefore manufacture no food and as a consequence are parasitic or saprophytic

4. To know lower plant forms bearing no chlorophyll may harm their host plant, and destroy much food

5. To know that forms of plant life that have no chlorophyll and therefore have no power to manufacture food are called fungi

6. To know that one-cell plant life needs food, oxygen, moisture, and favorable temperature for growth

7. To know that fungi are important because they (a) spoil food, (b) cause fermentation, (c) are used for food, and (d) cause diseases in plants and a few animals

8. To know that the lowest forms of plant life show no differentiation of roots, stems, leaves, and flowers

| Specific Objectives | Teacher Procedures |
|---|---|
| 7. To gain a knowledge of means of growth and reproduction of lower plant forms | 3. Spend a short time on the "splitting plants." Show that their only form of reproduction is by cell division. That each cell is capable of carrying on all the life processes. Take up the common forms (bacteria). The material on bacteria is more or less familiar so the class work should be in the nature of a new synthesis of material. Spend some time on useful and harmful bacteria and means of control |
| 8. To gain information on spore production | |
| 9. To know factors necessary for growth of plant forms | |
| 10. To gain a knowledge of means of control of lower plant forms | 4. Show that algae are the simplest plants containing chlorophyll, capable of making starch and are therefore independent. Take up something of habitat, common types, and means of reproduction |
| 11. To gain a knowledge of how some of the lower plant forms are of value to man and how some are harmful | 5. A study of fungi should be more extensive than that made of other thallophytes. Study means of reproduction, method of food getting, value to man, and injurious forms. Show ways in which they are adapted to the life they live |
| | 6. Lichens: Show curious partnership between a fungus and an alga. Their important work of converting rock into soil |
| | 7. Mosses: No attempt should be made to show the alternation of generation in mosses but study them by way of comparing with lower and higher plant forms and their marvelous adjustment to their environment |
| | 8. Make a brief study of ferns, showing how they differ from mosses, and how they are adjusted to their environment |
| | 9. Bring in as many problems as possible to make the unit concrete and to give opportunity to supervise the pupils' thought processes, and give drill in sound thinking |

### References


1. Atkinson, A., *Mushrooms,* Henry Holt
2. *Bacteria and the Nitrogen Problem,* Reprint 277 Yearbook, U. S. Dept. of Agriculture
3. Broadhurst, J., *How We Resist Disease,* Lippincott
4. Brown, J. F., *Health in Town and Home,* Heath
5. Buchanan, R. E., *Household Bacteriology,* Macmillan
6. Burnet, E. A., *Microbes and Toxins in Nature,* Putnam
7. Clute, W. N., *Ferns in Their Haunts,* Stokes

| Pupil Activities | Evidences of Mastery |
|---|---|
| 12. Bring into the laboratory for display various germicides and find out something about each | 9. To know mosses are higher in the scale than the thallophytes, they occur in most parts of the world and have no vascular system |
| 13. Report on the differences between antiseptics and disinfectant | 10. To know ferns represent a class of plants higher in the scale of plants than mosses. They have a vascular system, leaves, stem, and roots |
| 14. Report on heat as an agency which kills germs | 11. To know that some bacteria (one-cell plant) are useful because (a) they are nitrogen fixers on roots of legumes, (b) they are scavengers and decay producers, (c) they are useful in such processes as tanning leather, fermentation, souring of milk, making cheese, and preparing flax and hemp |
| 15. Try to find out the principle used in preserving foods by salting, smoking, pickling, canning, and cold storage | 12. To know how lower forms of plant life are held in check |
| 16. Bring in various labels from commercially canned fruit, catchup, etc. and notice labels to see if any of the following have been used: borax, formalin, salicylic acid, or benzoate of soda | 13. To know many forms of lower plants produce spores during unfavorable conditions |
| 17. Look up pure food laws | 14. To know that spores are formed by protoplasm forming a ball with a much thickened wall on outside |
| 18. Look up and report on the development of bacteriology | 15. To know that lower plant forms reproduce by cell division, some by budding, others by spore formation |
| 19. If red cedars are common in the community find what are termed cedar apples (a fungus growth) on them and try to work out the life history of this fungus, also the damage done to apple trees, hawthorns, and wild crabs | |
| 20. Read and report on the life of Pasteur | |

**References**

8. Conn, G. C., *Agricultural Bacteriology,* Blakiston

9. Conn, G. C., *Bacteria, Yeast and Mold in the Home,* Ginn

10. DeKruif, Paul, *Microbe Hunters,* Harcourt Brace

11. Gront, A. J., *Mosses with a Hand Lens,* A. J. Gront

12. Gruenberg, B. C., *Biology and Human Life,* Ginn

13. *Pure Food and Drug Act* (separate), 8th Revision, Circular 21, 1922. U. S. Department of Agriculture

14. Ritchie, J. W., *Primer of Sanitation,* World Book Co.

15. Wheat, V. H., and Fitzpatrick, J. B., *Advanced Biology,* pp. 510-527, American Book Co.

16. *National Geographic Magazine,* May, 1920, pp. 387-439

**Teacher Procedures**

10. Summarize the unit. This summary should show similarities and differences in the lower forms of plant life, basis used for classification of plants and how plants are adapted to their environment
11. Write a brief paper on ''Pleurococcus a typical plant''

**Notes by Teacher**

## IV. SOME TYPICAL ANIMAL FORMS

### Unit Objective

To gain a knowledge of the adaptations and life histories of some typical animal forms

### Specific Objectives

1. To become acquainted with some typical simple invertebrate and vertebrate animals

2. To gain an appreciation of the great number of animals and to know that only a specialist could hope to know all of the animals in any group. (Every high school pupil can derive pleasure from knowing about common animals.)

3. To develop the ability to identify the common insects, not to tell species, but to be able to put the insects in the large orders as beetles, bugs, flies, etc.

4. To gain a knowledge of the structural adaptations and life histories of insects, fish, crayfish, frogs, worms, and mammals

5. To appreciate the economic importance of the orders of animals

### Teacher Procedure

1. Make a brief survey of animal kingdom. Get pupils to formulate concepts about animal life they already know something about. What are the largest animals known? The smallest known? Show how one-celled animals are classed as protozoa (protos means first, and zoan means animal); while metazoan is an animal composed of many cells so combined that they form a single individual (meta means after and zoan means animal)

2. Make a study of some typical common animals of both the vertebrates and invertebrates. Pay particular attention to adaptations, economic importance and life histories. Any biology manual may be used for directions

3. Use earth worms, various insects, and snails for invertebrate study, and fish, garter snake, frog, toad, or birds, and any small mammal for vertebrate type

4. Groups should be assigned to bring in live specimens and find out their food, how they should be cared for in the laboratory and about their native habitat

5. Have a few specimens of crayfish collected and kept in a terrarium till needed. Pupils working in groups should observe how the crayfish is adapted for locomotion, methods of feeding, respiration, and something about their sensory responses. The external structure should be studied to show external skeleton, stalked eyes, mouth parts, and swimmerets
From references find out the life history of the crayfish, its close relatives and the economic value of the group (crustacea)

### Pupil Activities

Pupils will

1. Look up and report on various protozoans as to life processes and economic value

2. Stock a terrarium and find out from various references how the animals placed in the terrarium should be cared for and fed

3. Find out about food habits of the earth worms and bring in a great number, place in proper containers with soil and food, and use for study as well as food for other terrarium animals

4. Make a study of parasitic worms, their habits, and how controlled

5. Try making an ant nest for the laboratory for studying a social insect

6. Start a permanent collection of insects harmful to the garden,—the collection to be kept in the laboratory for future classes

7. Make a study of the coöperation among some plants and animals

8. Report on fish hatcheries of Iowa

9. Send to the Bureau of Entomology, United States Department of Agriculture for insect posters for the study of life histories of destructive insects

10. Report on the industry of button making from mollusca shells in Iowa

11. Each make a balanced equarium in a mason jar, using local aquatic life (plant and animal), keep it over a period of at least four weeks and record all observations made on the animals

12. Look up material on extinct animals

### Evidences of Mastery

1. To know the three great functions of living things are (a) nutrition and growth; (b) reproduction; (c) adjustment of organisms to the environment

2. To know that animals as well as plants to-day present an increasingly complex series from simple to complex

3. To know that greater complexity in animal life means increasing division of labor and specialization of function

4. To know that animals vary in habitats, habits, and structure to secure food and protection and success in life

5. To have a knowledge of the major phyla and classes of animals

6. To know the characteristics of the common phyla of animals

   Example: Characteristics of mammals
   a. The young are born alive
   b. They suckle their young
   c. The body is more or less covered with hair
   d. A diaphragm is present
   e. High circulatory development is present

7. To know that insects pass through a series of changes during their life history

| Specific Objectives | Teacher Procedure |
|---|---|
| 6. To gain a knowledge of the specialization of animals for food-getting and locomotion | 6. After other invertebrates are studied, make a comparison of forms studied, then generalize and summarize the similarities and differences |
| 7. To appreciate the need of conservation of some forms of animal life | 7. If an aquarium has been started in the fall and stocked with some native fish, these will be excellent for observation of vertebrates<br>Observe and record all adaptations noticed for locomotion, for protection, food-getting, and respiration<br>Use references and report on life histories of fish, and habits of various native fish |
| 8. To understand how diseases caused by parasitic worms can be avoided | 8. The toad makes an excellent animal to study. Make comparisons with fish already studied; and record observations on adaptations for locomotion, food-getting, respiration, and hibernation.<br>Special reports may be given on other representatives of the amphibian group, and also on the life history and habits of the various amphibians |
| 9. To know the chief characteristics of the various phyla of vertebrates | 9. Find out the chief characteristics of mammals and the important orders. Compare with other vertebrates studied. |
| 10. To understand the life functions of the frog as a foundation for human physiology | 10. Birds make an interesting animal to study because of their beauty, accessibility, and adaptations. Study the birds' adaptations for flight, and active life, migration, and food. Take field trips in fall or winter to study them |
| 11. To overcome superstitious ideas about reptiles | 11. A small amount of time might be spent on primates and the ways in which man resembles and differs from other primates |
| 12. To recognize the steps of growing complexity in a series of animal forms | 12. After the type studies of the various animals of both invertebrates and vertebrates in a general discussion period work out a classification of well known animals to give a bird's-eye view of the animal kingdom |
| 13. To get a general view of the animal kingdom | |

### References

1. Cockerell, T. D., *A Zoology*, World Book Co.

2. Comstock, J. H., *Manual for the Study of Insects*, Comstock Publishing Co., Ithaca, New York

3. Dickerson, O. M., *The Frog Book*, Doubleday Doran

| Pupil Activities | Evidences of Mastery |
|---|---|
| 13. Make out a list of Iowa mammals | 8. To know what is meant by complete and incomplete life histories among insects |
| 14. Report on Hornaday's book, *Our Vanishing Wild Life* | 9. To know that insects are the most numerous of all animals |
| 15. Collect and mount pictures of various animals to be filed and left in the laboratory | |
| 16. Make a study of special adaptations of whale, seal, bat, mole, flying squirrel, giraffe, opossum, duckbill, kangaroo | 10. To know the specialization for food-getting and locomotion among insects |
| 17. Report on our vanishing fur bearers | 11. To know insects are numerically superior to other animals because of<br>a. Their power of flight<br>b. Small size and adaptation in color<br>c. Remarkable power of reproduction |
| 18. Report on propagation of wild life | |
| 19. Report on domestication of wild animals such as silver fox and muskrat | |
| 20. Report on damage done to various crops by insects, using graphs and tables to illustrate | 12. To know the principal methods of controlling harmful insects:<br>a. Natural enemies<br>b. Poisons and traps<br>c. Environmental factors |
| 21. Look up and report on the European corn borer. Exhibit may be obtained from the Extension Department of Iowa State College at Ames, Iowa | |
| 22. Start a survey of various forms of animal life of the community that carry or cause disease | 13. A limited knowledge of insect orders; to be able, for example, to put insects into the various orders, know why some are classified as flies, others as beetles, etc. |
| 23. Obtain from bulletins and other references information that will help solve such problems as harm done by the following insects: flies, clothes moths, weevils, ants, cutworms, potato beetles, squash bugs, and plant lice | |
| 24. Make a survey to determine the number and kind of insect pests in the locality | 14. To have an acquaintance with structural adaptations of the type animals studied |
| 25. Plan a bird census to be taken by each biology class, the records to be kept on file in the laboratory for future use | 15. To know the many problems of adaptations, survival of the fittest, and struggle for existence among animals |

### References


4. Ditmar, L., *The Reptile Book,* Doubleday Doran

5. Farmers' Bulletin 606, *Collecting and Preserving Insects,* U. S. Department of Agriculture, Washington, D. C.

6. *Geological Survey of Iowa Rodents,* Geological Survey of Iowa, Des Moines

7. Guthrie, J. E., *Snakes of Iowa,* Extension Department, Iowa State College, Ames

8. Holland, W. J., *Butterfly Guide,* Doubleday Doran

9. Linville, H. R., and Kelly, H. A., *Textbook in General Zoology,* Ginn

10. Lutz, F. E., *Field Book of Insects,* Putnam

11. *National Geographic Magazine,* July 1927, July 1929, and May 1919

12. Stone, W. and Cram, R., *American Animals,* Doubleday Doran

13. *Turtox Service Leaflet No. 2,* General Biological Supply House, Chicago. This leaflet tells how to preserve specimens

14. Wheat, V. M., and Fitzpatrick, C. R., *Advanced Biology,* American Book Co.


### Teacher Procedures

13. Summarize the unit and bring out the concept that an increasingly complex series from simple one-cell forms to complex forms, and that greater complexity means division of labor and specialization of function

14. Some objective form of test over the unit should be constructed

| Pupil Activities | Evidences of Mastery |
|---|---|
| 26. Plan a feeding station to be kept supplied with food for birds during the winter | 16. To know what local, state, and national organizations are working for conservation of some useful animal life |
| 27. Report on protective concealment of animals | 17. To acquire a greater interest in birds which will provide an occupation for leisure hours |
| | 18. To have an increased understanding of human physiology through the study of other animals |

Notes by Teacher

# V. BIOLOGY OF THE HUMAN BODY

## Unit Objective

To develop a greater appreciation on the part of the pupils of the significance of physical health

## Specific Objectives

1. To get specific facts concerning structure and functions of the parts of the body

2. To determine factors that tend to interfere with the normal health; also the factors that promote health

3. To develop a state of "health consciousness" that will lead to a continuation of good health habits in the future

4. To gain a knowledge of the structure and adaptations of the skeleton

5. To understand the interrelationship of the bony and muscular systems

6. To appreciate the importance of a scientific knowledge of diet and nutrition

7. To develop a wholesome interest in selection of a proper diet for a minimum of money

## Teacher Procedure

1. Present evidence to show that the study of man is the most interesting of all animal study; man has the same life processes as other animals studied; his body is also similar to other vertebrates studied; and his organs and tissues are made up of cells having the same characteristics as cells of both plants and animals

2. Make a general study of the structure and uses of the skeleton. Use charts or manikin. Test bone to find out organic and inorganic constituents

3. Make a general study of muscles. Study kinds, action, nerve and blood supply, food and fatigue of muscles. Take up importance of exercise, correct posture, and general hygiene of the muscles

4. Present nutrition under these suggested topics: meaning of calorie, uses of different classes of food, vitamins, preparation of foods, adulteration of foods, digestion and absorption of food, hygiene of eating, and foods and disease.

   Experiment to show digestion of starch and necessity for thorough mastication of food. Demonstrate to show digestion of protein and fat. Demonstrate to show the necessity for digestion of starch

   Make a brief study of the adaptations of the alimentary canal for absorption of food

5. Present respiration as follows: Study location and function of lungs and air passages. Get lungs of beef for laboratory study. Bring out in the study the adaptations of blood vessels and air sacs for the interchange of gases. Take up hygienic

| Pupil Activities | Evidences of Mastery |
|---|---|
| Pupils will | |
| 1. Heat bones in a fire and report result | 1. To know that bones are constructed and related so as to combine lightness and strength, flexibility and rigidity |
| 2. Place bones in a strong acid for a time and report results | 2. To know that the development of the bones depends upon sunlight and diet |
| 3. From pictures and references and from live specimens compare the skeletons of insects, turtles, frogs, mollusks, and man | 3. To know differences in bones of young and old |
| 4. From various sources find out and report on diseases of the bones and their treatment | 4. To know the effects of bad posture and to know correct positions of the body in standing and walking |
| 5. Find and bring in material on orthopedic defects | 5. To know first aid methods for sprains, fractures, and dislocations |
| 6. Find out and report on the first aid treatment for sprains, dislocations, and fractures | 6. To know how to select proper shoes |
| 7. Report on various essential types of exercises | 7. To know that correct posture is important to health and depends partly on mental attitude |
| 8. Examine charts and tables for food values then list the most important foods which supply each of the main essentails of diet | 8. To know that digestion produces the following changes in foods:<br>(a) it makes it soluble to allow its transfer<br>(b) changes it chemically to permit assimilation |
| 9. Work out 100-calorie portions of common foods and display in the laboratory | 9. To know that organic proteins, fats, carbohydrates, and vitamins are classified as organic foods while water and mineral salts are classified as inorganic food stuffs |
| 10. Make graphs to show value of food compared with its price | |
| 11. Read and report on patent medicines | |
| 12. Work out simple rules to be followed in selection of one's diet | |
| 13. Work out daily calorie requirement | |
| 14. Get tripe from butcher shop and study and report on the increase of surface of the digestive tube | |

| Specific Objectives | Teacher Procedures |
|---|---|
| 8. To gain a knowledge of digestion (mechanics and chemistry) | habits of breathing, proper methods of ventilation to secure exchange of oxygen and carbon dioxide. |
| 9. To appreciate the necessity of caring for the digestive system | 6. Emphasize these points under circulation: Study general structure of blood. If possible have a microscopic demonstration of capillary circulation. Use web of frog's foot, tail of tadpole, or small fish<br>Get beef heart and demonstrate gross structure of heart |
| 10. To gain a knowledge of the circulatory system | |
| 11. To develop a sensible and intelligent attitude toward local, state and national organizations concerned with safeguarding our food supply | 7. Make plain the significance of excretion. Suggested topics for study: organs of excretion and their adaptation of structure to function, hygiene of organs of excretion |
| 12. To develop the concept that good health is dependent upon intelligent eating and proper selection of food | 8. Study the nervous system and sense organs. Make a brief survey of the principal parts of the nervous system and their functions<br>Show that the nervous system is the coordinating machinery of the body. Use charts, models, and diagrams for the study of the sense organs (the organs that interpret what goes on about us). The hygiene of the nervous system should be discussed to bring out the fact that rest and exercise are important in the developing of the nervous system |
| 13. To develop an interest in reading about the human body | |
| 14. To gain a knowledge of the excretory organs of the body | |
| 15. To learn some facts about the coördinating machinery of the body | |

**Pupil Activities**

15. Collect material dealing with structure and hygeine of the teeth

16. Find out from observation and references the types of respiratory organs of insects, fish, earthworms, protozoan, and snails

17. Compare ordinary air with the expired air as to percentage of nitrogen, oxygen, carbon dioxide, water vapor, heat and organic impurities

18. Demonstrate artificial respiration to the class (Schaefer method)

19. Demonstrate how to stop the flow of blood in case of an accident; where to exert pressure in case of hemorrhage; bandaging for arterial bleeding; or how to check nosebleed

20. Report on life and work of William Harvey

21. Devise a means of measuring the lung capacity of the class and determine the average

22. Get kidney of sheep or other animal from butcher shop and study the general structure

23. Study models and diagrams of the sense organs to find out their structure, use, and hygiene

24. Compare eye and camera

25. Report on effect of drugs on the nervous system

**Evidences of Mastery**

10. To know that the number of calories needed by any person depends on age, occupation, and climate

11. To know the major digestive organs and their functions

12. To have a general wholesome knowledge of the hygiene of the digestive system. This should include:

    a. Importance of mastication

    b. Length of time to digest common foods

    c. Proper time of eating

    d. Proper time of eating sweets

    e. Eating between meals

13. To know the lines of defense against dental disease:

    a. Proper diet in childhood

    b. Cleaning of teeth

    c. Dental examination at least once a year

14. To have a knowledge of the organs of circulation and their care

15. To have a knowledge of organs of respiration; their structure, function, and care

16. To know the chief values of exercise

**Notes by Teacher**

**Evidences of Mastery**

17. To know the organs of excretion, their structure (in general) and care

18. To know the parts of the nervous system

19. To know that the nervous system is mainly for control and to keep us in touch with our surroundings

20. To know the nervous system is made up of cells which are highly specialized, their main work being to transmit and interpret stimuli

21. To know that the nervous system must be fed just as muscles and skin are fed

22. To know that to keep the nervous system in good condition requires proper rest and relaxation

# VI. INHERITANCE

## Unit Objective

To comprehend the principles underlying the improvement of plants, animals and human stock

## Specific Objectives

1. To understand the significance of variation and heredity

2. To gain a knowledge of what is meant by Mendelism

3. To realize there are definite laws of heredity

4. To develop a wholesome interest in heredity

5. To develop an understanding of how biology helps improve the race and environment

6. To gain an understanding of heredity as applied to plants and animals

7. To understand that individuals vary and that they vary in definite ways

8. To get some understanding of the complex organization of the germ cells

## Teacher Procedures

1. In an earlier unit the fact was brought out that the living matter of all plants and animals is protoplasm. Now bring out the fact that protoplasm is alike in certain elements that compose it and in the fact that all protoplasm is sensitive to stimulation, that it all grows by assimilation yet protoplasm of one species is different from another species. These differences are thought to be located in certain parts of the chromosomes called genes
From diagrams, charts or models study cell division

2. Discuss variation in various plants and animals. These problems of likenesses and differences are problems of heredity

3. Discuss environment as a factor influencing development (temperature, moisture, light, and food)

4. Take up somatic variation and germinal variations. Use enough examples to get the distinction
Somatic (body) variations are variations caused by environment and affect body cells of organism but not the germ cells. They affect the individual without affecting greatly the offspring. Germinal variations are a part of the ancestry because they are in the genes of fertilized egg. Germinal variation is something that influences the individual's development and makes him different from others that live in the same environment

5. Make a study of the Mendelian laws of inheritance, with many preliminary experiences to pupils to insure that the words used in stating the laws are meaningful. Many

### Pupil Activities

Pupils will

1. Demonstrate the law of chance.

   (a) Use several hundred black beans and the same number of white beans. After mixing draw out two beans at a time without looking

   Score results and state the proportion of two black to a combination of one white and one black, and to two white

   (b) Toss coins at least one hundred times then total scores and summarize

2. Prepare a report on the life and work of Gregor Mendel

3. Using a pair of characters in cattle, show how they may breed through two generations. Show all possible combinations in the offspring

4. Diagram, using Punnett square, the Andalusian fowls through two generations

5. Diagram the Japanese four o'clocks through two generations

6. Report to class on recent science books or magazines the experiments that are now being carried on concerning mutations

7. Give floor talk on how a particular trait may be established in plants and animals

8. List all the new animals and plants that modern man has produced

9. Compare members of class in biology and indicate some of the variations

10. Look up and report on pedigree of any animal

### Evidences of Mastery

1. To know that heredity includes a study of all the various characteristics in the offspring that are more or less similar to those characters of the ancestors

2. To know that no two individuals are ever exactly alike

3. To know that development of the organism depends largely upon the character-determiners of the genes

4. To know that temperature, light, food, and moisture are some of the factors that influence the development of plants and animals

5. To know that abnormal forms result from a variety of unfavorable conditions during the development of the offspring

6. To know that characters that are inherent in the individual are known as germinal variations

7. To know that differences that depend upon environment are known as somatic variation; that they affect the individual without, to any great extent, affecting the offspring of the individual

8. To know what is meant by unit characters

**References**

1. Bailey, W. M., *Plant Breeding,* Macmillan

2. Davenport, C. B., *Heredity in Relation to Eugenics,* Henry Holt

3. Downing, Elliot, *The Third and Fourth Generation,* University of Chicago Press

4. Gruenberg, B. C., *Biology and Human Life,* Ginn

5. Guyer, M. F., *Being Well Born,* Bobbs Merrill

6. Jewett, Mrs. Frances, *The Next Generation,* Ginn

7. Walter, H. E., *Genetics,* Macmillan

8. Wheat, V. M., and Fitzpatrick, J. B., *Advanced Biology,* Chapters 32-37, American Book Co.

**Teacher Procedures**

problems must be given so pupils may have practice in applying the laws to situations until they can use them intelligently

6. Show that mutation and mutants are of economic importance to man since they can be used as a starting point for new species of plants and animals and should therefore be studied

7. Take up the importance, methods, and results of plant and animal breeding

8. Present eugenics: its history and suggestions for race improvement

9. Summarize the work of the unit and give some form of test to check the mastery of the unit

| Pupil Activities | Evidences of Mastery |
|---|---|
| 11. Report on the two notable defective families: the Jukes and the Kallikaks | 9. To know what is meant by a hybrid, incomplete dominance, complete dominance, pure type, unit characters, recessive, and segregation |
| 12. Look up and report on the Delicious apple | 10. To know the Mendelian laws of heredity and to be able to apply them |
| 13. Report on the life and work of Luther Burbank | 11. To know that the particular aims of plant and animal breeding are to produce new species, to breed desirable characters, to improve quality by proper selection, and to make old and new forms more productive |
| | 12. To know that plants and animals have been greatly improved by experimental breeding |
| | 13. To know that breeding of plants and animals is based upon sound scientific principles |
| | 14. To know that experts in heredity by the use of the Mendelian laws can predict with a great deal of accuracy what characters will be inherited and in what proportion |
| | 15. To know that the application of the principles of heredity to man is called eugenics |

## VII. THE MAKERS OF BIOLOGY

### Unit Objective

To acquire an admiration for the self-sacrifice of men in the interest of human welfare

### Specific Objectives

1. To learn about a few of the great biologists who have contributed to human progress

2. To be able to trace briefly the progress of biology

3. To learn about the methods used by great biologists

4. To know the contributions made by great biologists

5. To arouse enthusiasm and interest in research work in biology

6. To appreciate how the contributions of early biologists affect the people of to-day

7. To develop an interest in reading about the lives of such men as Pasteur, Lazear, Jenner, Lister, Koch, and others

### Teacher Procedures

1. Like all sciences, biology has developed from small beginnings by the labor, sacrifice, and study of many men over a long period of years

Have pupils start with Aristotle (300 B. C.) and make a study of the distinguished biologists and their contributions down to the present time

Take up in particular those men that developed the idea of the germ nature of disease and its application to problems of human welfare

The following is a suggested list of men to be studied:

| | | |
|---|---|---|
| Aristotle | Priestly | Reed |
| Galen | Jenner | Stiles |
| Harvey | Schleiden | |
| Malpighi | Schwann | |
| Leeuwenhoek | Agassiz | |
| Hooke | Pasteur | |
| Linnaeus | Darwin | |
| Huxley | Lazear | |
| Mendel | Burbank | |
| Lister | De Vries | |
| Metchnikoff | Weismann | |
| Laveran | Audubon | |
| Koch | Lamarck | |

Much of this unit could be covered by special reports. Direct pupils' attention to histories and biographies where material may be collected

The reports should be given in order, that is, reports of earliest contributors given first so that the class may see how later scientists based their work on discoveries of earlier scientists. Certain factual material of this unit can easily be tested, but much aimed at in the specific objectives cannot be tested by a written examination. This might better be checked by the type of voluntary reading done by pupils

### Pupil Activities

Pupils will

1. With the aid of teacher make a list of the important biologists

2. Take one or two names from the above list and prepare a report to be given to the class

3. Note the countries represented by the men reported upon

4. Find out whether America featured in the development of biological sciences prior to the Civil War

5. Find out about the invention and improvement of the microscope

### Evidences of Mastery

1. To know that scientific progress is due to scientific discoveries and the intelligent application of these discoveries to our lives

2. To know that biology has rendered great service in the progress of the world

3. To know the work of distinguished men who have aided biologic progress

4. To know how old some of our biologic principles are, and how young is our definite knowledge sufficient to apply them

### References

1. Kinsey, A. C., *An Introduction to Biology*, Lippincott

2. Locy, W. A., *Biology and its Makers*, Henry Holt

3. Locy, W. A., *The Growth of Biology*, Henry Holt

4. Osborn, George, *From the Greeks to Darwin*, Scribner

# A SUGGESTED UNIT

# A TREE SURVEY OF THE COMMUNITY

## Unit Objective

To know the common trees of the community, their products, and importance

## Specific Objectives

1. To develop the ability of pupils to make and record accurate observations

2. To appreciate the value of trees to the community

3. To gain an interest in the problems of the community

4. To know how trees grow

5. To learn to identify by means of a simple key

6. To become acquainted with at least 25 deciduous trees and the most common genera of conifer trees of the community

7. To know the economic value of trees

8. To direct individual interests

9. To understand some of the principles of tree culture

## Teacher Procedure

1. This unit might be started by a study of the uses of trees to man. Such uses as control of water supply, benefits to soil, homes for birds and other animals, and effect on climate should be studied as well as the various tree products

2. Enemies of trees such as grazing animals, fungus diseases, insects, fire, man, and weather might be given in form of special reports. It is well to get figures on amount of damages done by these agencies annually

3. Reports and discussion on protection of trees should be called for. These should include laws, reforestation, government forest reserves, forest rangers, forestry schools, fire protection, value of birds to forest industry, and other topics bearing on the subject of forest protection

4. A brief study of the two general classes of trees, conifer and deciduous trees, should be made. Show that the term conifer is a better word to use than evergreen. Also discuss the terms hard and soft wood. Term *hard wood* is applied to all deciduous trees and *soft wood* to conifers. It makes no difference if cottonwood or willow is softer than some pine. The former is hard wood and the latter soft wood

5. Get simple leaf keys such as appear in Downing, *Our Living World,* or Conard, *Our Trees,* and practice using them by bringing various leaves into the classroom and working together to become familiar with the way to use the key

**Pupil Activities**

Pupils will

1. List all the uses of trees to man. Have a committee compile the results and report to the class

2. List all the products of trees and if possible get figures on the annual production in U. S. of these products

3. Write to the Forest Service, U. S. Department of Agriculture, get material on the work of the forest ranger and give a report

4. Find out what courses are required in your state agricultural college for forestry

5. Find out through various references something about forestry abroad and report your findings

6. List all the ways you think of in which conifers and deciduous trees differ. Include differences in climate, soil, and rainfall where each is most common and try to account for these differences

7. Collect fruits and leaves of common trees. Put fruits in boxes and label. Press the leaves and mount on heavy cardboard backed with white paper; cover with old window glass, cut to the proper size and tape together with tape, label each mount on the back

8. Try various ways of making leaf prints (by using blue print paper, carbon paper, ink, or paint) and keep a record of all leaves of trees studied

9. By means of various references look up historical trees and report on them

10. Make a survey of forest resources of your state

**Evidences of Mastery**

1. To know that trees offer protection from wind, control water supply, add humus to the soil, make homes for animals, and give many products such as lumber, paper, fuel, naval stores, tanning materials, sugar, and prevent erosion

2. To know forests are protected by laws, forest reserves held by government, careful lumbering, re-planting, forest rangers, and instruction to people through forestry schools

3. To know that men by careless lumbering and fires are the worst enemies of the forests

4. To know that other enemies are insects, fungous diseases, grazing animals, and weather conditions

5. To know that not all conifer trees hold their leaves throughout the year

6. To know that all conifers bear cones

7. To know that the wood of all conifers is termed *soft wood*

8. To know that all conifers have a habit of growth that is peculiar: the trunk runs straight from base to tip and the branches spring from trunk in whorls

| Specific Objectives | Teacher Procedures |
|---|---|
| 10. To know places of biological interest in the community | 6. By means of field trips with keys and other references make a tree survey of the community |
| 11. To accumulate information about trees in the local community for the reference library in biology | 7. Suggestion for tree survey: use trees on or near the school ground at first. Show how bark, method of branching, twigs, leaves, fruit, and form of tree may be used for identification. Also show how accurate records and observations are necessary<br>Each trip review the trees identified previously and take several new ones. Identify in field by use of keys or pictures and descriptions from such books as *Handbook of Native Trees of Iowa*<br>There are about 500 kinds of trees in United States; of these about 150 are used for lumber and the most favored locality will have about 50 or 60 of these. It should be a matter of pride for high school pupils to know the names of the trees in the locality |
| 12. To build up a permanent interest in trees | |
| 13. To gain a knowledge of the care of shade trees | |
| 14. To know the general classes of trees: conifers and deciduous | |
| 15. To create a greater interest in and enjoyment of outdoor life | |
| 16. To create an interest in and a means of identification of common trees | 8. As the trees are identified have pupils make a collection of leaves and fruit for a permanent teaching collection |
| 17. To gain some knowledge of the principles of landscaping | 9. Look up the uses of the wood of the trees identified |
| | 10. Prepare a form to use in keeping a permanent record of each kind of tree identified and prepare an exhibit |
| | 11. Make a survey of the trees in the town. This may be done by dividing the class into groups and give each a convenient area to report on |
| | 12. Have an interesting report on the trees of the locality written and published in the local paper. Much interest is aroused if when telling about the various trees, examples are located, as the largest specimen of horse-chestnut in town is at 883 Main, in Mr. Marsh's yard |

| Pupil Activities | Evidences of Mastery |
|---|---|
| 11. Learn how lumber is cut and how to recognize the cut | 9. To know how to identify the common genera of conifers (pines, spruce, fir, larch, hemlock, juniper, and arbor vitae) |
| 12. Study tops of desks, floor or other wood at hand to determine the kind of cutting | |
| 13. Make an exhibit of the common woods of your locality. Polish the cut surface, label, and put in the school laboratory for future classes to use | 10. To know that all broad-leafed trees in this region are spoken of as deciduous |
| 14. Find out what curly maple is and report to class | 11. To know that the wood of deciduous trees is termed as *hard wood* |
| 15. Look up the origin of coal and peat | 12. To be able to use a simple key to trace the genus and species of broad-leafed trees |
| 16. Find out something about your state parks and something about trees of each | |
| 17. Look up all locations of forest preserves in United States | |

**Teacher Procedures**

13. Good prints of leaves may be made with printer's ink, carbon paper, blue print paper, or by painting the back of the leaf with oil paint then pressing the painted surface on the paper

14. After the tree survey is completed, a study of forestry as a vocation might well be discussed

15. If time permits make a brief study of formation of coal and peat

16. Various identification tests may be used to test pupil's knowledge of trees. Take pressed leaves, mount on cardboard, number them and have pupils write the species name; or an identification test may be given in the field

17. Have pupils identify trees in local park and attach labels. Names of tree may be burned in soft wood then nailed to the tree

18. Take a trip to nearby places of interest (state parks, county property, cemeteries, etc.) and collect information on location of various trees and shrubs. This should be carried on by each class over a period of years until definite information has been collected concerning places of biological interest

19. A brief study of how to beautify yards, streets, and parks can be taken up. Observe on trips: yards, parks, and streets that are attractive because of their landscaping. Analyze the characteristics of good landscaping. This is a good place to take up tree surgery and care of street trees

20. Study briefly trees that attract birds and the value of birds to trees

21. Summarize the unit and give objective test over essentials

## References


1. *Boy Scout Handbook,* Boy Scouts of America

2. Conard, H. S., *Our Trees,* H. S. Conard, Grinnell, Iowa. 15 cents

3. Downing, E. R., *Our Living World,* Longmans Green

4. Government Bulletins from United States Department of Agriculture,
   Farmers Bulletin #1492, *Arbor Day*
   Farmers Bulletin #1087, *Beautifying the Farmstead*
   Farmers Bulletin #1453, *Conifers*
   Farmers Bulletin #1209, *Planting and Care of Street Trees*
   Farmers Bulletin #1388, *Rural Planning*
   Farmers Bulletin #1482, *Trees for Roadside Planting*
   Circulars #21, *1928 America and the World's Woodpile*

5. *Handbook of Native Trees of Iowa,* Extension Department, Iowa State College, Ames. 5 cents

6. Hawksworth, H., *A Year in the Wonderland of Trees,* Scribner

7. *Life History Charts,* Comstock Publishing Company, Ithaca, N. Y.

8. Moseley, E. L., *Trees, Stars and Birds,* World Book Co.

9. *Principal Uses and Physical Characteristics of Commercially Important Woods of the U. S.,* Forest Service, U. S. Department of Agriculture, Washington, D. C. Free

10. Rolfe, Mary A., *Our National Parks,* Book I and II, Sanborn

11. Sponsler, O. L., *Trees,* George Wahr Publishing Company, Ann Arbor, Michigan. $1.50

12. *The Forestry Primer,* Forestry Department, Iowa State College, Ames

13. *Tree Planting Book,* American Tree Association, Washington, D. C. Free

# APPENDIX

## Manuals for Teacher or Pupils


1. Atwood, W. W., *Problems, Projects, and Experiments in Biology,* P. Blakiston
2. Bailey, G. A., and Green, R. A., *New Laboratory Manual,* Allyn and Bacon
3. Colton, B. P., *Zoology, Descriptive and Practical,* Heath
4. Gruenberg, Benjamin C., *Laboratory Manual for Biology,* Ginn
5. Hunter, G. W., *New Laboratory Problems in Civic Biology,* American Book Co.
6. Moon, T. J., *Laboratory Manual for Beginners,* Henry Holt
7. Peabody, J. E., *Laboratory Exercises,* Henry Holt


## General Biological Reference Books for Teacher Use


1. "Bibliography of Science Teaching in Secondary School," *Bureau of Education Bulletin,* No. 13, U. S. Department of Interior, 1925. 20 cents
2. Chapman, F. M., *Handbook of Birds of Eastern North America,* Appleton
3. Comstock, J. H., *Insect Life,* Comstock
4. Curtis, F. D., *Investigations in the Teaching of Science,* P. Blakiston
5. Dickerson, O. M., *Frog Book,* Doubleday Page
6. Ditmas, L., *Reptile Book,* Doubleday Page
7. Downing, E. R., *Our Living World,* Longmans Green
8. Downing, E. R., Report of an Investigation to Determine the Time Required to Teach Certain Units in Biology to the Point of Mastery, *The North Central Association Quarterly,* Vol. 5, No. 4, (March, 1931)
9. Downing, E. R., *Teaching of Science in the Schools,* University of Chicago Press, 1925
10. Downing, E. R., "The Biology Course Outline in Major Objectives," *School Science and Mathematics,* May, 1929
11. Hodge, C. F., *Vivarium and Aquarium Keeping for Amateurs,* Witherby
12. Innes, W. T., *The Modern Aquaria,* Innes

13. Keeler, H. L., *Our Native Trees and How to Identify Them,* Scribner

14. Lloyd, F. E., and Bigelow, E. F., *Teaching of Biology,* Longmans Green

15. Lutz, F. E., *Field Book of Insects,* Putnam

16. Ruch, G. M. and Stoddard, G. D., *Tests and Measurements in High School Instruction,* World Book Co., 1927

17. Ruch, G. M., *The Objective or New-Type Examination,* Scott Foresman, 1929

18. Sponsler, O. L., *Trees,* George Wahr Publishing Co.

19. Stone, W., and Cram, R., *American Animals,* Doubleday Page

20. Thompson, L. R., *Outlines of Science,* Putnam

21. Transeau, E. N., *General Botany,* World Book Co.

**Textbooks of Biology for Pupil Reference**

1. Atwood, W. W., Biology, P. Blakiston, 1927

2. Bigelow, M. A., and Bigelow, A. N., *Applied Biology,* Macmillan, 1914

3. Clement, A. C., *Living Things,* Iroquois Publishing Co., 1924

4. Gruenberg, B. C., *Biology and Human Life,* Ginn, 1925

5. Hunter, G. W., *New Civic Biology,* American Book Co., 1926

6. Kinsey, A. C., *An Introduction to Biology,* Lippincott, 1926

7. Linville, H. R., *The Biology of Man and Other Organisms,* Harcourt Brace, 1923

8. Meir, W. H. D., and Meir, G. W., *Essentials of Biology,* Ginn, 1931

9. Moon, T. J., *Biology for Beginners,* Henry Holt, 1925

10. Needham, M. M., *General Biology,* Comstock Co., 1924

11. Peabody, J. E., and Hunt, A. E., *Elementary Biology,* Macmillan, 1928

12. Smallwood, W. M., Reveley, I. L., and Bailey, G. A., *New General Biology,* Allyn and Bacon, 1929

13. Trafton, G. H., *Biology of Home and Community,* Macmillan, 1923

14. Wheat, V. M. and Kitzpatrick, J. B., *Advanced Biology,* American Book Co., 1929

15. The following *National Geographic Magazines* are very helpful for identification purposes:

July, 1922, Midsummer Wild Flowers
May, 1925, Ferns
July, 1927, Common Moths and Butterflies
May, 1927, The Family Tree of Flowers
January, 1928, Bird Banding
June, 1928, Humming Birds
July, 1928, Crabs
May, 1929, The Eagle in Action
July, 1929, Insect Number

**Notes by Teacher**

**Notes by Teacher**